CNS/ATM Planning: Modeling USAF and Civilian Air Traffic Interactions in European Airspace

Presentation for ICNS

3 May 2006

The MITRE Corporation

Edward Wigfield, Kelly Connolly, Alexander Alshtein, James DeArmon, Richard Flournoy, William Hershey, John James, Paula Mahoney, Jennifer Mathieu, John Maurer, and Paul Ostwald

Background

- **On 3 April 1996 a military version of the Boeing 737 crashed in Dubrovnik, Croatia**
  - **Sec. of Commerce Ronald Brown one of 35 killed**
  - **USAF investigation found faulty navigation equipment partly to blame**
- **Global Access, Navigation, and Safety (GANS) program established in 1997**
  - **Focal point for Air Force requirements**
- **Air Force policy (2001)**

  "Conform to the appropriate civil communication, navigation, surveillance/air traffic management (CNS/ATM) performance standards to guarantee access to worldwide controlled airspace".

Some key points

- **CNS/ATM capability is expensive**
  - **Equipment costs *plus* integration costs**
  - **Range up to millions of dollars per aircraft**
- **Mobility Air Force (MAF) supports Combat Air Forces (CAF)**
  - **Different platforms, different philosophies, and different goals**
- **US Air Force is a user of civilian-managed airspace**

Key Assumptions

- **Civilian Air Traffic will continue to increase**
  - **In line with Eurocontrol forecasts**
- **Political considerations will drive stricter regulatory environment**
  - **Basing limitations**
  - **Denial to airspace access; waiver process delays**
- **Flexible Use of Airspace (FUA) and European Single Sky initiatives will further constrain military**
  - **Limited availability of special use airspace (SUAs)**
  - **ALTRVs (reserved air corridors) will be hard to obtain**
  - **Missions will be required to fly within civil traffic**
  - **Longer Military routes to mission operations areas**

Analysis Hypothesis

- **Premise: Aircraft equipped with specific CNS capabilities gain from civil authorities**
  - **More optimal routing; more efficient use of civil airspace**
  - **Reduced airspace denials**
  - **More flexibility resulting from less setup time and planning**
- **Premise:Uncertainties regarding use of civil airspace drive workarounds and contingency planning**
  - **Pilots plan for worst case**
  - **Result is inefficient mission plans and in-transit routing**
- **Hypothesis: Aircraft with better CNS capability gain…**
  - **Reduced variability in arrival times**
  - **Improved ops tempo**
  - **Better resource utilization**
  - **Improved dynamic task execution**

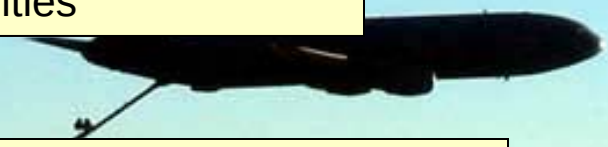
Analysis Process

1. **Falconview, standard Mission Planning tool, generated air routes**
   - Accomplished at detailed level; operationally realistic
   - First cut at tanker/fuel utilization
2. **Military routes overlaid on civilian traffic in CAPER**
   - Congestion impact assessed at sector level by altitude
   - Weather based on U.S. experience
   - Refueling variance based on AMC inputs/experience
3. **CAPER output passed through Monte Carlo process**
   - Ran five hundred missions per day; 100 trials per aircraft;
   - Partitioned results into four periods per day
   - Variance resulting from weather, congestion, and refueling
   - Ops tempo metrics for individual aircraft and tanker utilization
4. **Individual aircraft ETAs and variance aggregated to assess strike package formation**
   - Failures to form strike packages can be varied to reflect experience
5. **Number of failures used to generate AOC impacts in MSim model**
   - Failures to form strike packages treated as critical event within AOC

Hypothetical Mission

Objective:
Air strike on a military airport in Southwest Asia

Scenario 1:
- Fighters based in UK
- Current and future CNS/ATM capabilities



Scenario 2:
- Fighters based in Eastern Europe
- Current and future CNS/ATM capabilities
- Include a fighter drag case

Notional Strike Package:

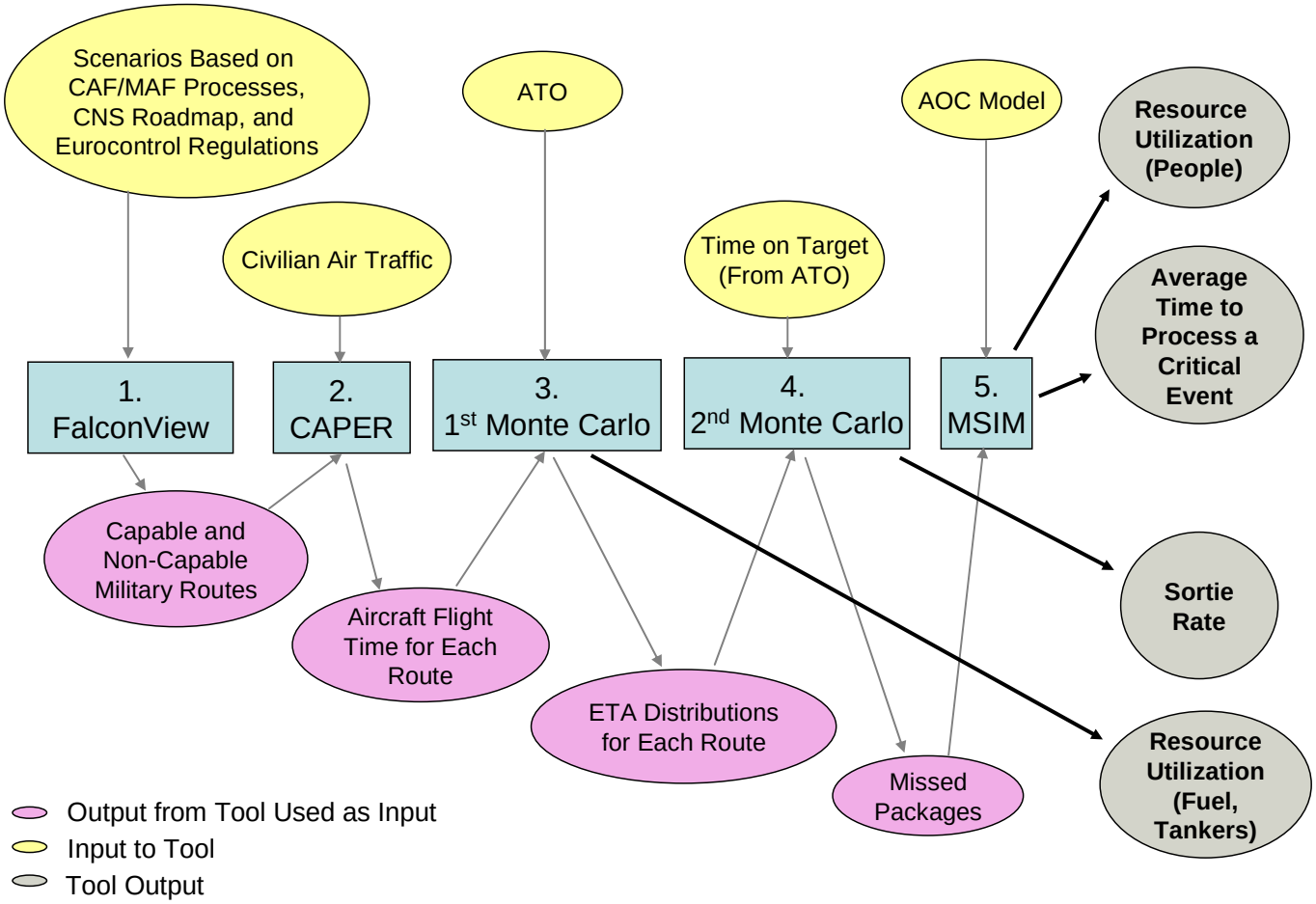
B-52 (1)
F-15D (4)
F-15C (2)
F-16C (4)

E-3
E-8
RC-135

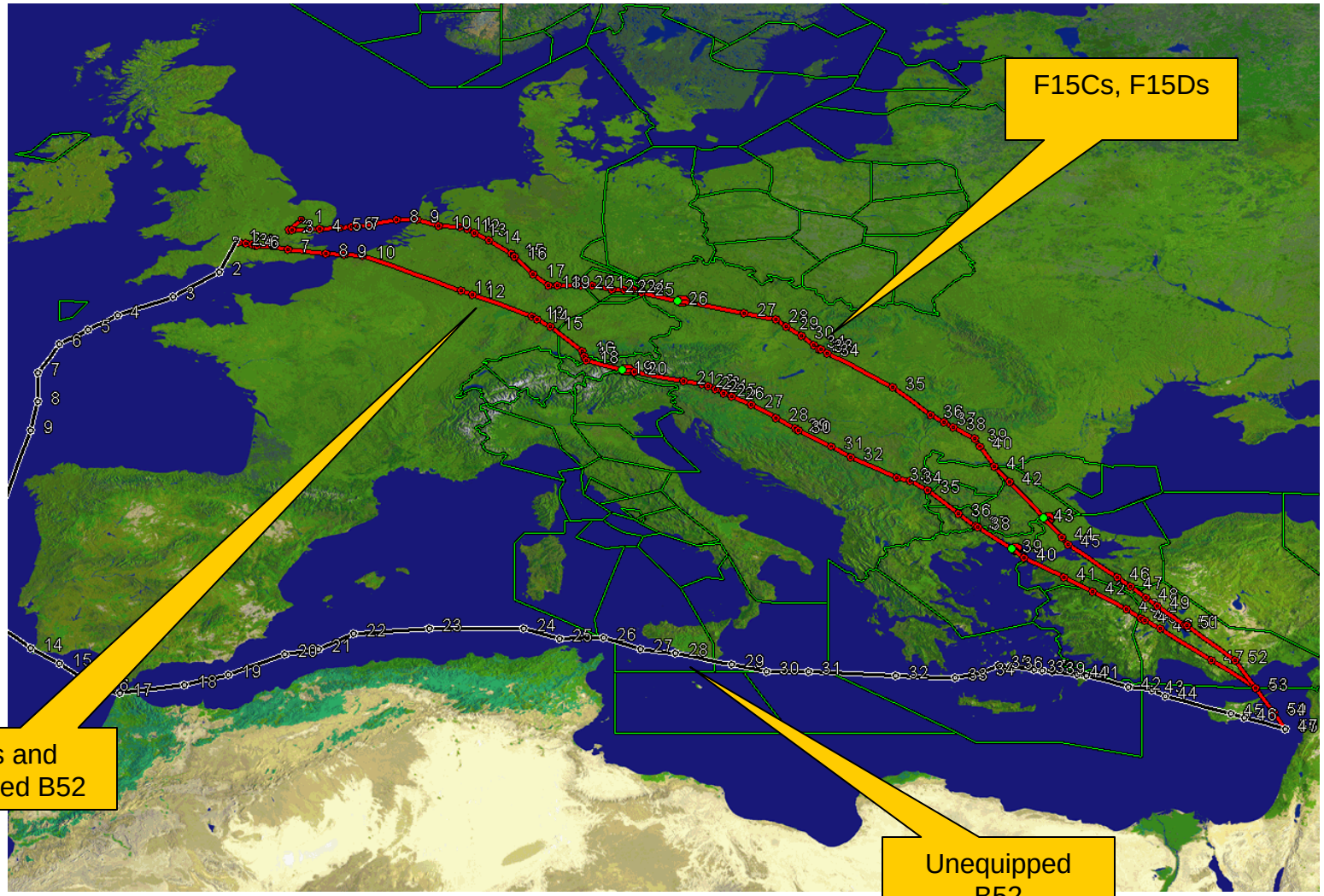
KC-10

CNS Capabilities Considered:
- 8.33 kHz Voice Communications
- FM Immunity

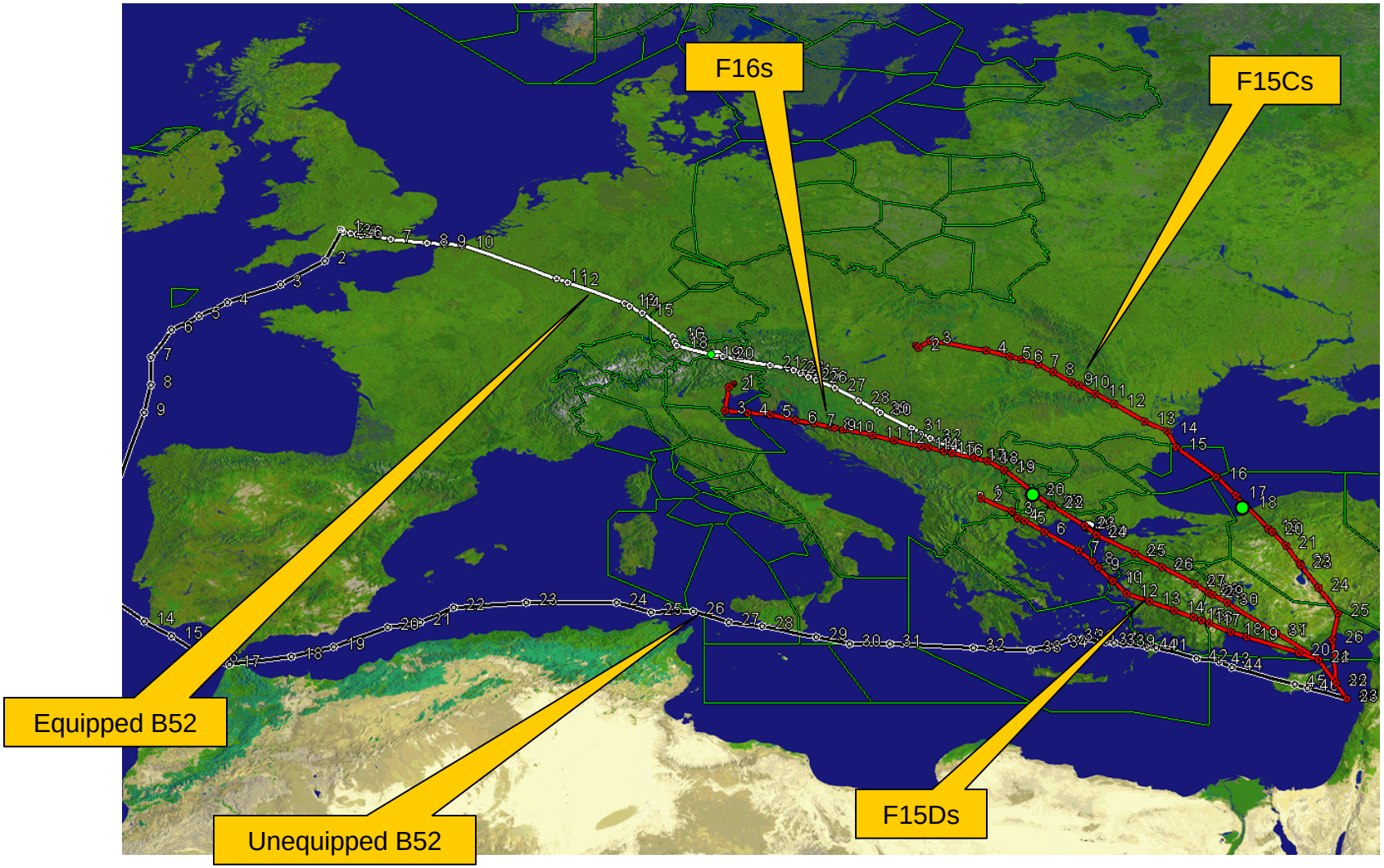
Steps of Analysis and Tools used in CNS/ATM Impact Study



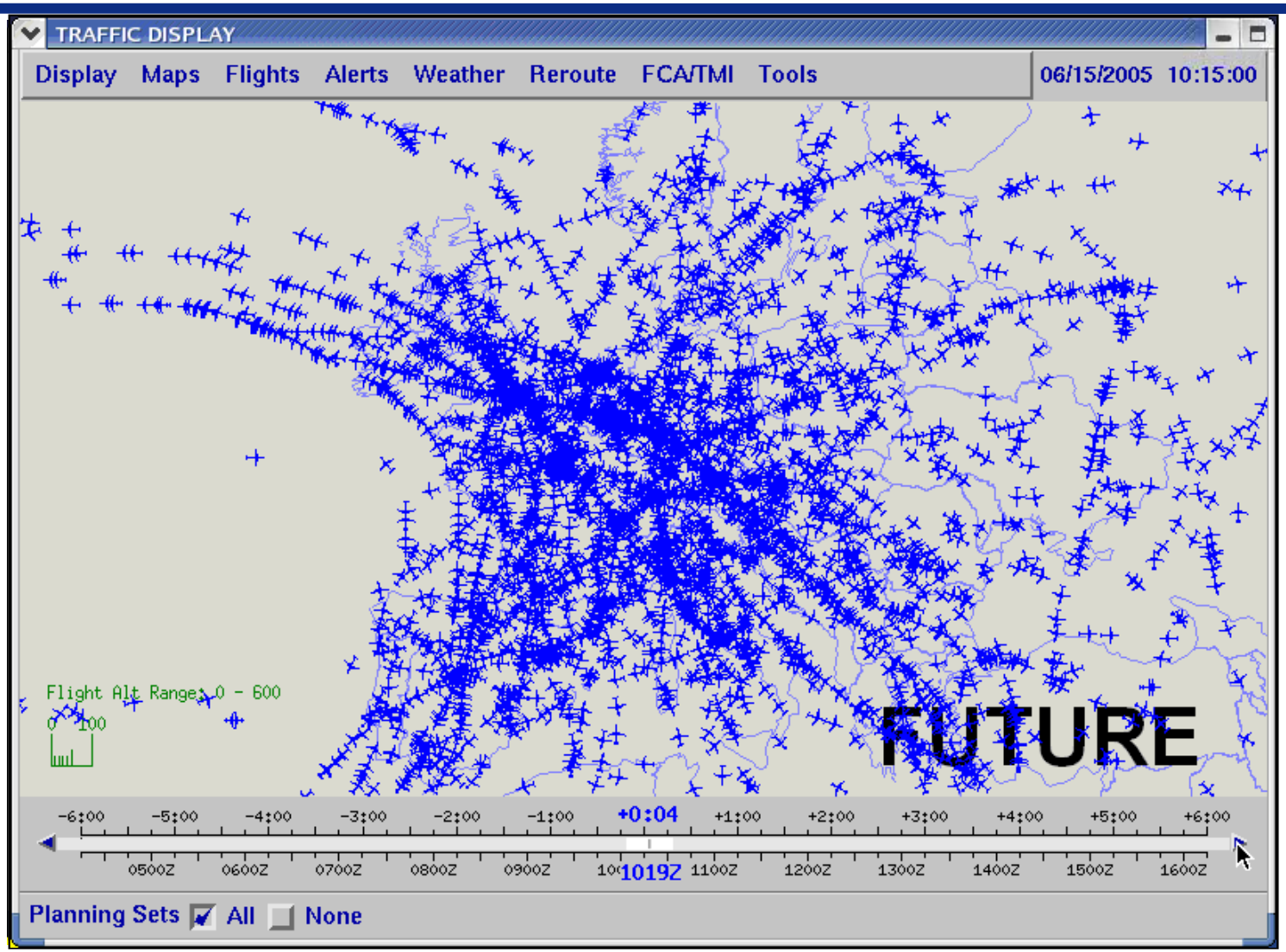
Fighter and Bomber Routes
UK-Based Scenario



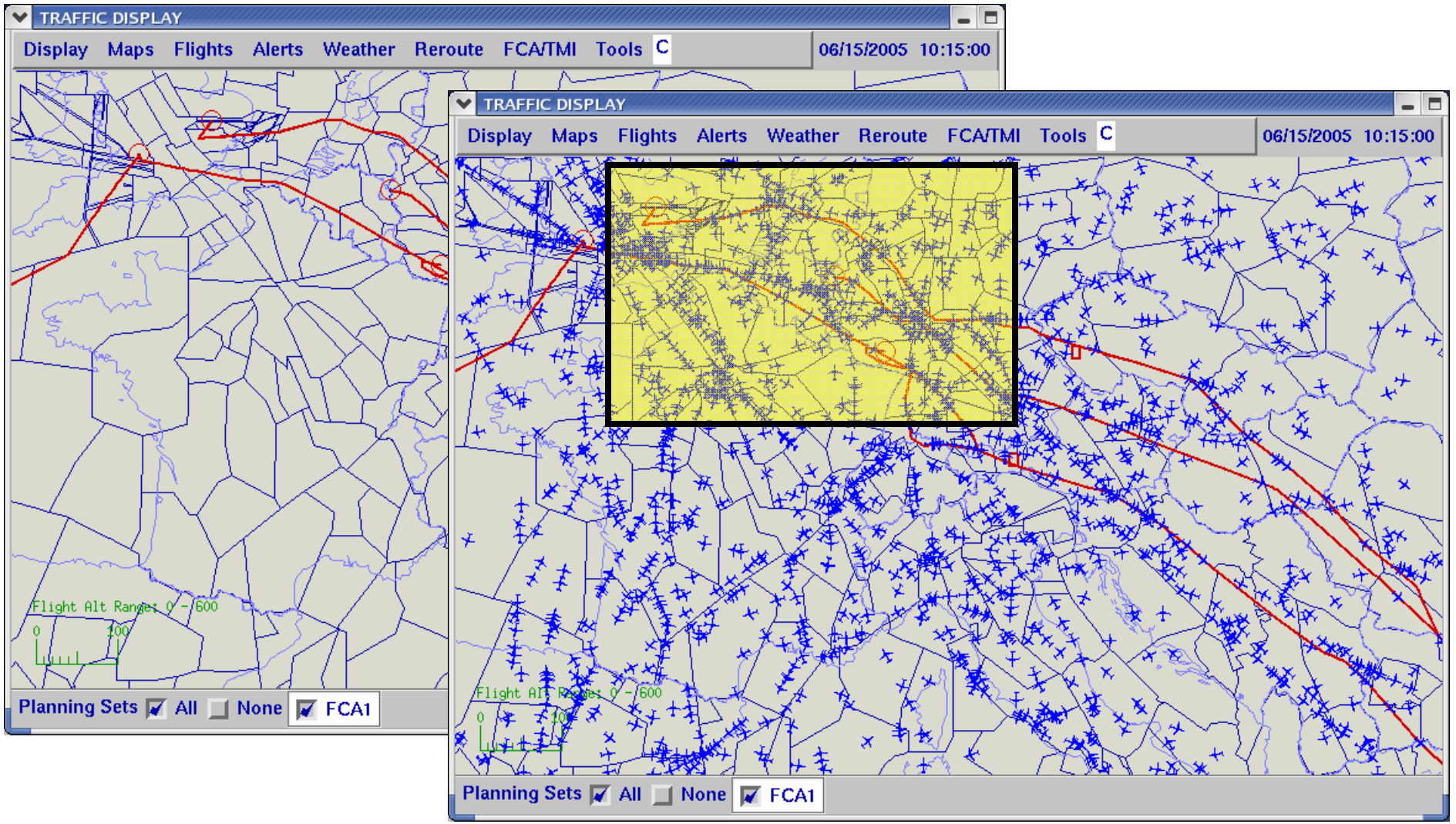
Fighter and Bomber Routes European-Based Scenario



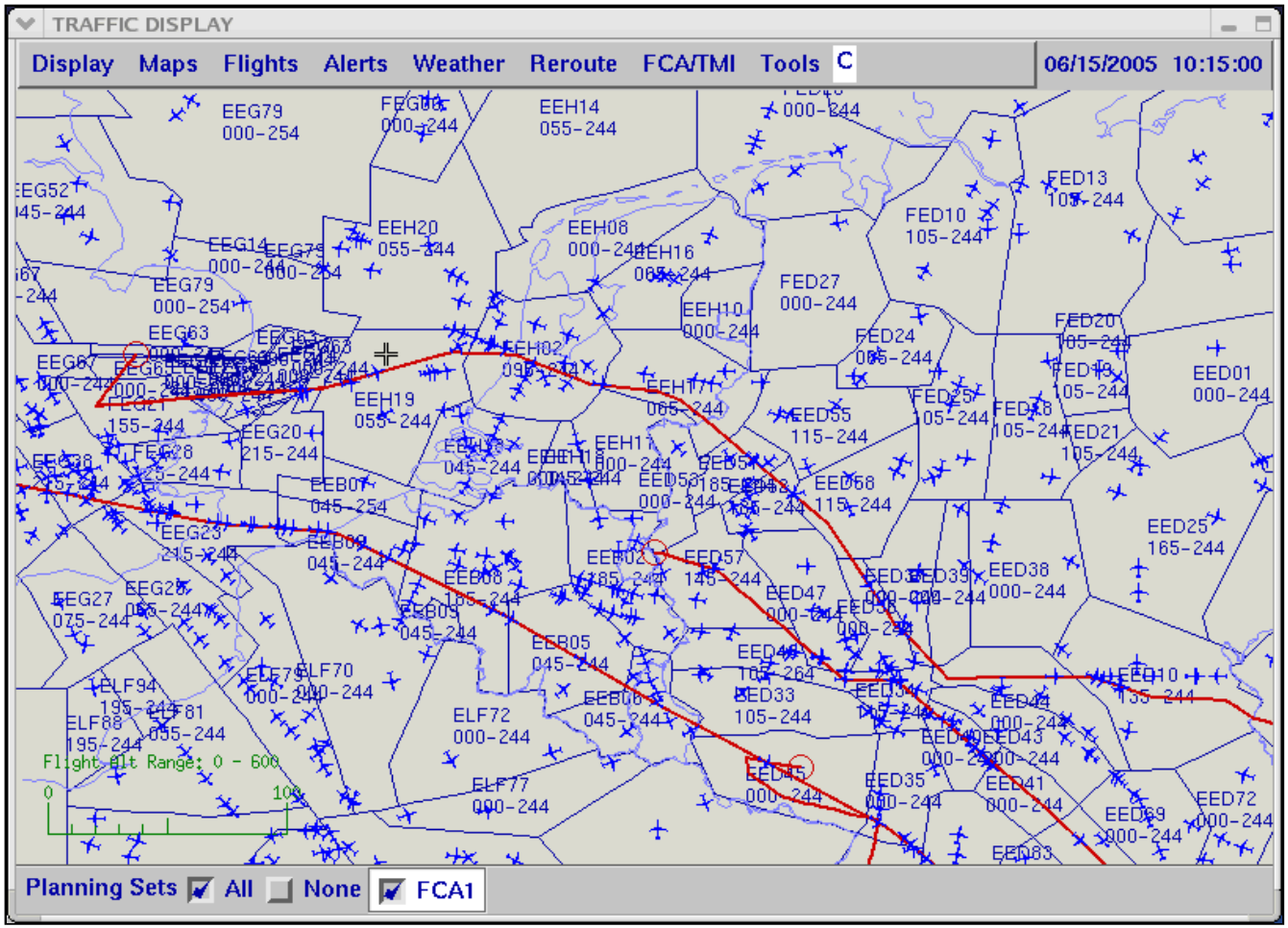
Civilian Air Traffic Visualization



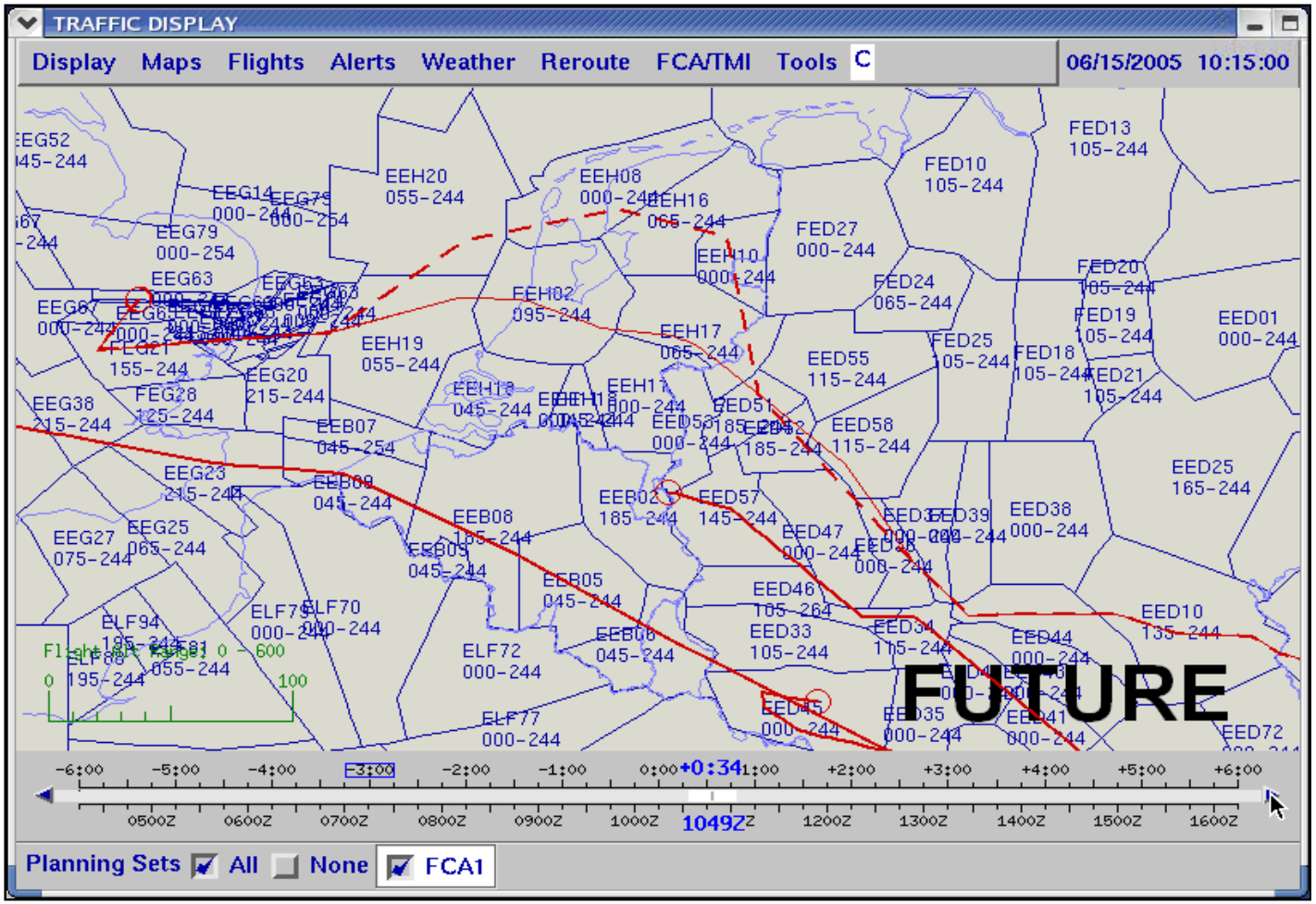
Structured Routes



Model Reroute



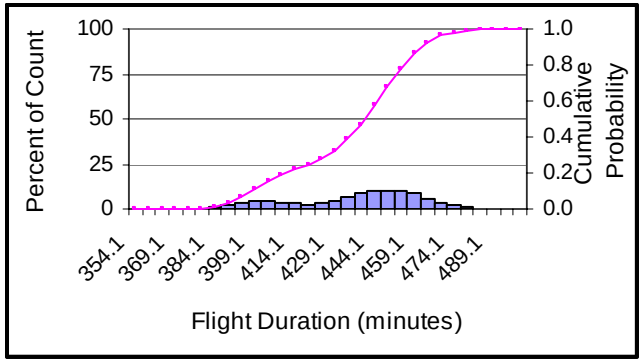
Execute Reroute

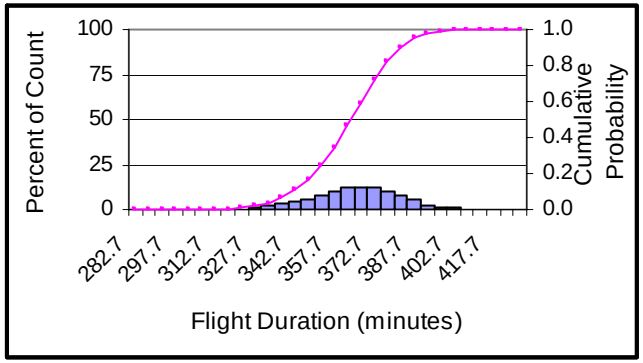


Bases in UK, F-15C, Time Period 4

Not Capable: 435 minutes, 134 spread **CNS Capable:** 363 minutes, 107 spread

2010

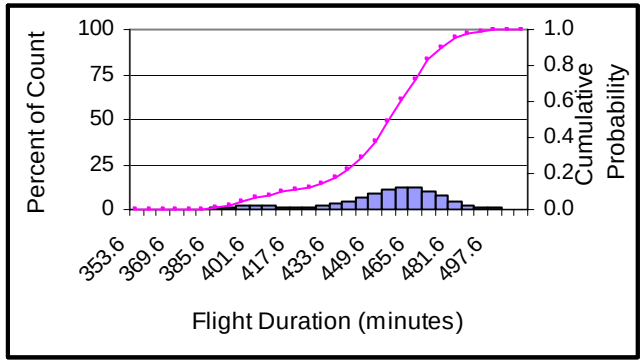


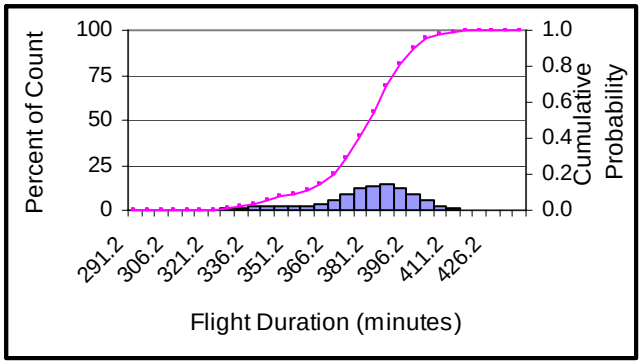


CNS Capable:
- 72 minutes faster and
- 27 minutes less variability

Not Capable: 451 minutes, 145 spread **CNS Capable:** 377 minutes 133 spread

2015





CNS Capable:
- 74 minutes faster and
- 12 minutes less variability

The CNS capable case arrives faster, with better predictability.

ME1

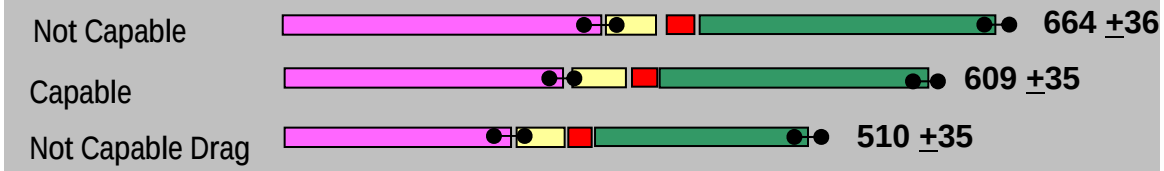
Package Formation

(4 Aircraft, Time Period 4, 2010)

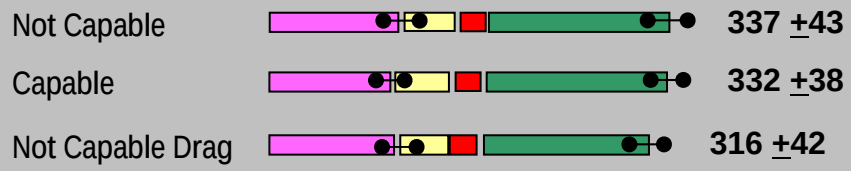
Note: sortie rate shows relative differences not absolute values

Base in Hungary (F-15C)

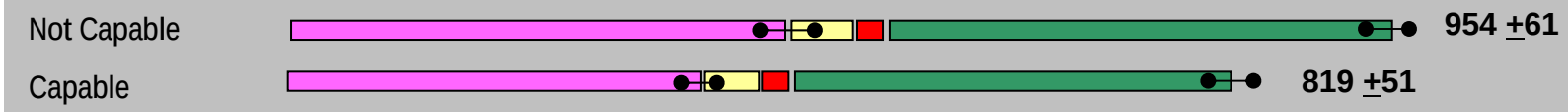
Base in Italy (F-16C)



Base in Macedonia (F-15D)



Base in the UK (F-15C)



Sortie Rate

2.9
3.1
7%

3.3

2.2
2.4
8%

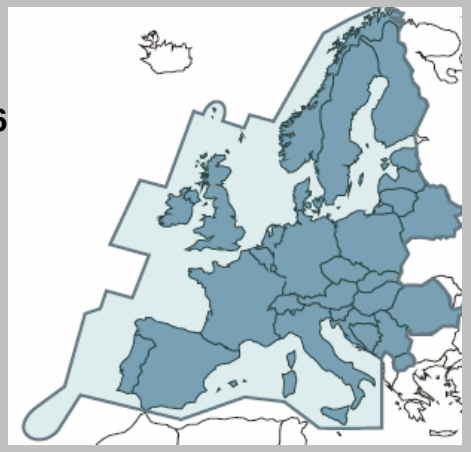
2.8

4.3
4.4
2%

4.5

1.7
2.0
15%

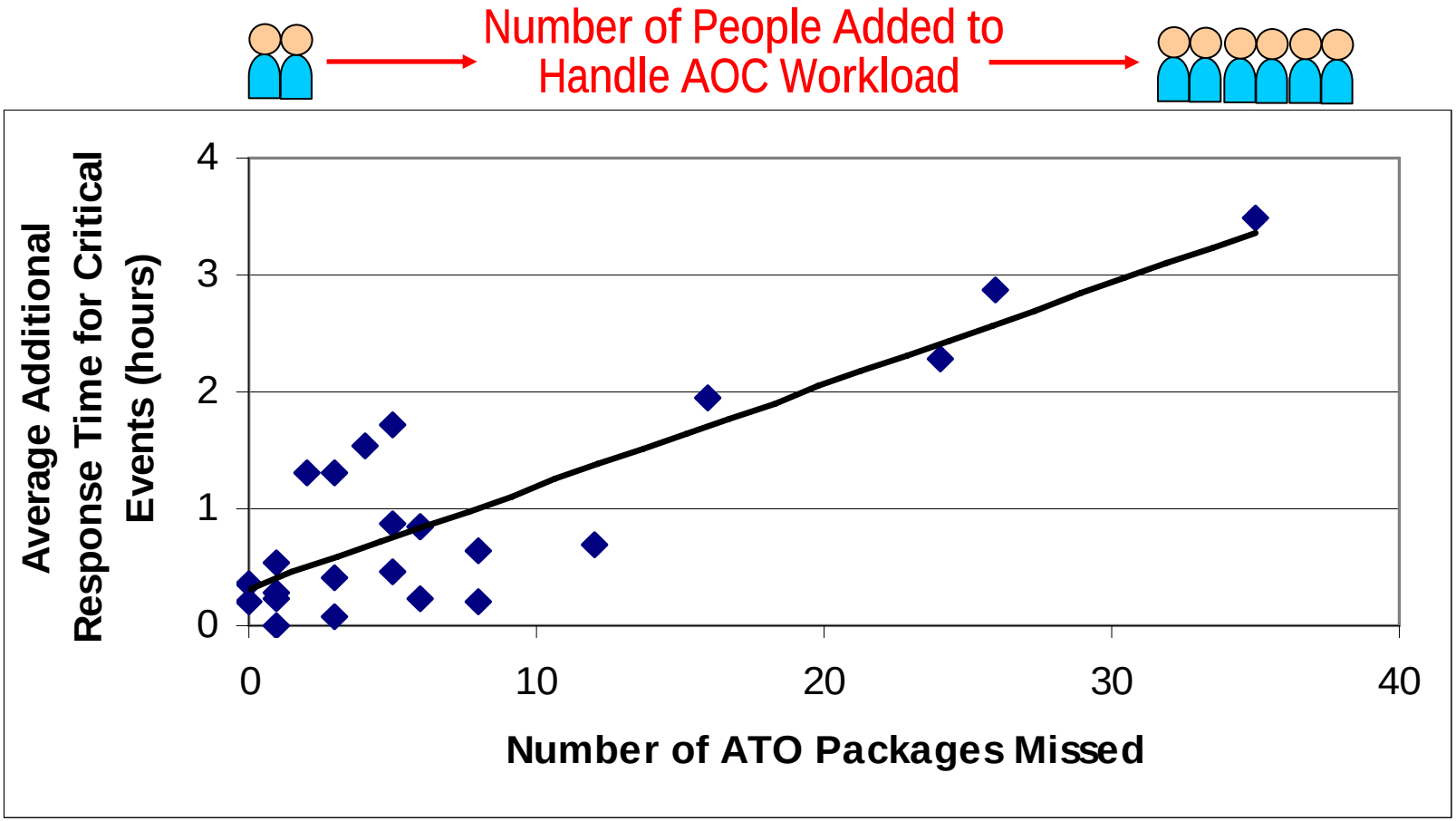
8.33 Area



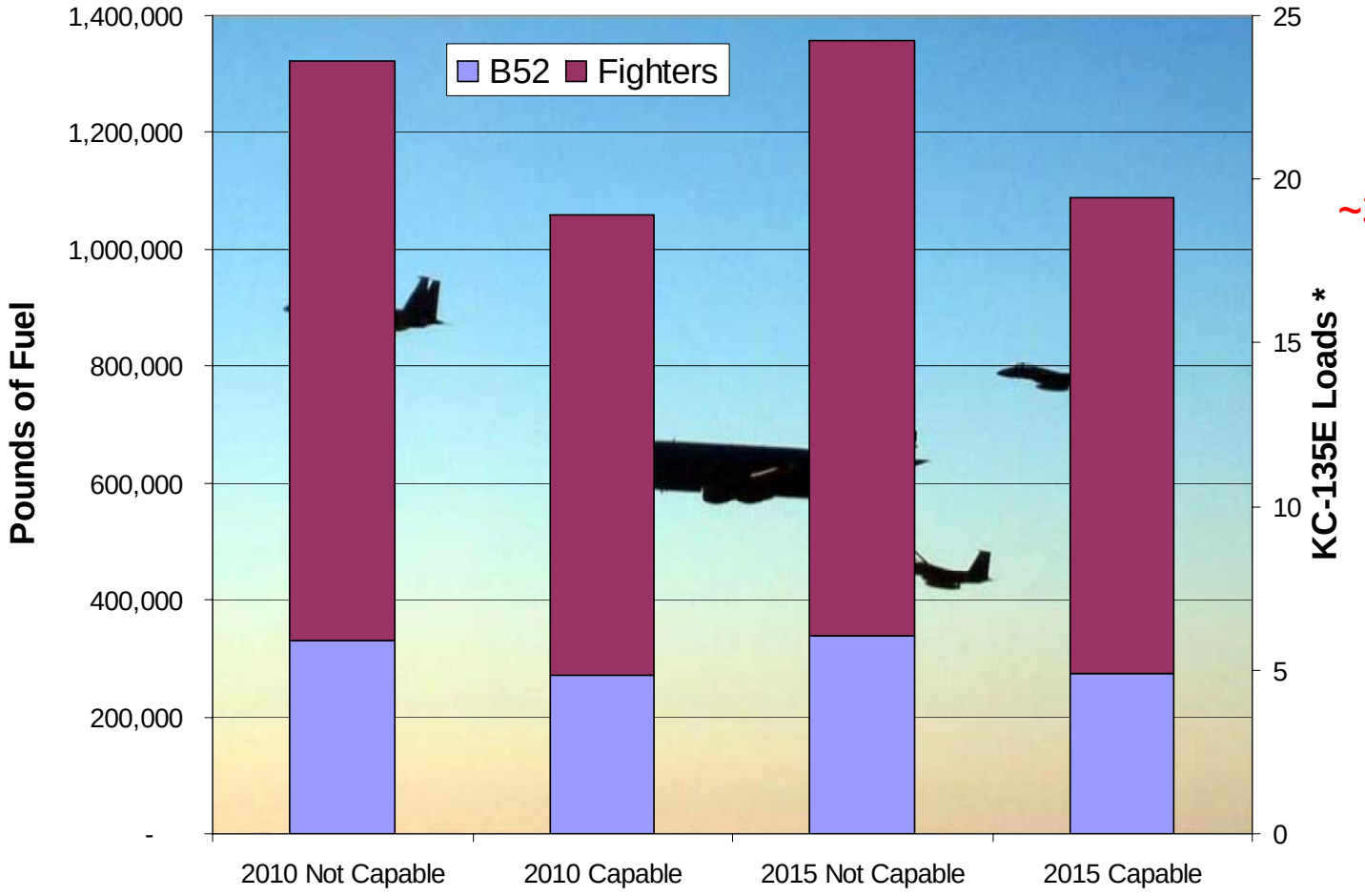
2 σ

In Transit, Waiting at Marshaling Point, Completing Attack Phase, Return

Effect of Packages Missed on Critical Event Response Time



Package Fuel Requirements (Bases in UK)



For Both 2010 and 2015,

~300,000 lbs more fuel is used,

equivalent to 5 more Tankers

* Estimate of gross number of KC135E assumes 1500 nm mission radius and takeoff at standard sea level atmosphere on 10,000 ft dry runway

Workarounds Produce Ripple Effects

- **Significant cross-enterprise feedback between CAF, MAF, and civilian ATM**

- **CAF workarounds produce wide-ranging ripple effects:**
  1. **Tanker Drag**
     - **For CAF perceived to work well BUT for MAF inefficient use of tankers**
  2. **Leave Earlier**
     - **Greater assurance of on-time arrival, BUT, sortie rates decrease, limiting flexibility. ETA variance unchanged, loitering continues at marshalling point wasting fuel.**
  3. **Plan to avoid regulated airspace**
     - **BUT flight time, fuel consumption, crew wear and tanker usage all go up. Sortie rates decrease, reduced flexibility.**
  4. **Special Use Airspace (SUAs), Altitude Reservations (ALTREVs)**
     - **Can work well BUT bilateral negotiations required; potential economic impacts; no guarantees, future availability in doubt**

Phase 2 Summary

- **Validated hypotheses: CNS capabilities analyzed provide considerable operational improvement for scenarios studied**
  - **Reduced ETA variability and associated waiting times**
  - **Reduced tanker utilization and fuel expense**
  - **Improved sortie rates**
  - **Improved capability for dynamic tasking at AOC**

- **Workarounds can maintain ability to get to a specific place at a specific time, at least over the short run**
  - **Impacts are wide-ranging and increase over time**
  - **Current workarounds may be unavailable in the future**

- **Can support enterprise decision processes**
  - **CNS/ATM roadmap (other capabilities, platforms, scenarios)**
  - **Specific issues, e.g., ability to address funding reductions of E8 CNS/ATM program**
  - **Flow of assets into AOR (by integration with AF ICE)**